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THE OAK TREE AND MAN'S ENVIRONMENT

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We are beginning to develop a new mental attitude toward the universe, toward our environment. This is the attitude of scientific testing and scientific utilization—a question of great importance to the economic geographer, who is primarily interested in the study of lands as the home of man. In the weighing of lands to determine their value to man, the geographer has had to change his scales every time science has put into his hands a new set of weights. This has happened frequently, and with the advance of science it is likely to keep on happening with increasing frequency. Since coal has entered into use, great shifts of industry, population, and power have resulted. Coal has entered into our thinking, and we have made an entirely new appraisal of the countries of the world. Water-power is now causing another revaluation of lands.

Cement affords an excellent example of the method by which new environmental factors enter into our lives. The discovery of the art of reinforcing concrete with steel opened up suggestive but undefined possibilities. What were these possibilities? Thousands of tests in many laboratories helped to give the answer on its technical side. The new works of the civil engineers gave the answer on the structural side, while geologists and mineralogists scoured the world to locate the materials for the making of cement.

The comfort of man has been increased, and little-used districts have quickly become populous through the sudden fervor of our investigation and adoption of cement after the discovery of the art of making reinforced concrete had, within a decade, made it an effective part of the environment. Perhaps this is to be our method. It should be. For every discovery, as in the case of cement, we should have the means at hand to search the earth and experimentally test out all promising leads.

Thus may man's life become adjusted to his environment, and thus may his activities conserve and improve it. The consistent adoption of such a philosophic attitude toward the earth will present a strong contrast to our past. In the past we have utilized our environment in the most haphazard way, and as to the concept of the whole environment as an influence, why, the race seems never to have thought of it.

What is our environment? Without attempting to define it fully, I will venture the somewhat definitive statement that, for man as an animal inhabiting the earth, those environments are good which permit the winning of a sufficient supply of nourishing food and at the same time permit the maintenance of health and energy.

Man knows far less about his relations to his environment as an *animal* than he does about his relation to his environment as a maker and user of cement. I am glad to note that there are signs among geographers of increasing interest in the study of the environment as it affects man. Those concerned for the welfare of the race should hope that our mass of working knowledge may be increased by the concept that the environment is something to be reckoned with, as is the transportation service or the supply of moving-picture shows. Thus far man has thrown himself about the earth's surface most blindly, more blindly by far than the migrating wild geese. In the main the geese know (environmentally) where they are going. They go into lands that are good for geese and other lands they leave alone. It is peculiar how the young gosling has been so much better taught than the young man. Man has repeatedly and continually gone into environments that destroy life through disease or diminish culture through the destruction of energy. Man is still doing it with all the reckless abandon of the age of the conquistadors. The average high-school or college graduate in the United States today has a strangely uniform concept of the earth. He comes into the professor's office and talks of seeking his fortune in South America as though the Spanish language were the only difference between that much-praised continent and Wisconsin or Pennsylvania. Such happenings are an impeachment alike of science, for neglecting the study of environment, and of education, for neglecting to teach youth some of the important environmental facts that appear to be firmly fixed in the minds of the young of the wild goose. I rejoice that investigation of the environment as such has begun. May it speedily increase until man knows as much about regions as a home for the race as he now knows about them as homes for cement factories. This knowledge may help man to take as good care of himself then as he now does of a cement factory.

Along with use of the earth comes inevitably the idea of conserving the earth and its resources. The two ideas should be inseparable, and it is one of the tasks of civilization to make them so. We may use and destroy as the savage and the civilized alike have so often done, thus keeping alive the saying "after man the desert"; or we may use the earth and leave it almost unimpaired, in some respects even much improved by our tenancy. This idea of scientific utilization of our environment will claim much more of our attention if we look forward to a long sojourn of a numerous race of men upon this planet. Here again we have shown ourselves much the inferiors, cosmically speaking, of our planetary brethren, the geese. We have destroyed. They have not. The aim of the so-called conservation movement is that the group shall compel the individual to cease destroying the environment. This movement has great reason for being, but it has not yet gone very far. Except for some tree planting, the conservation idea has, up to the present, produced little but a string of thou-shalt-nots, and

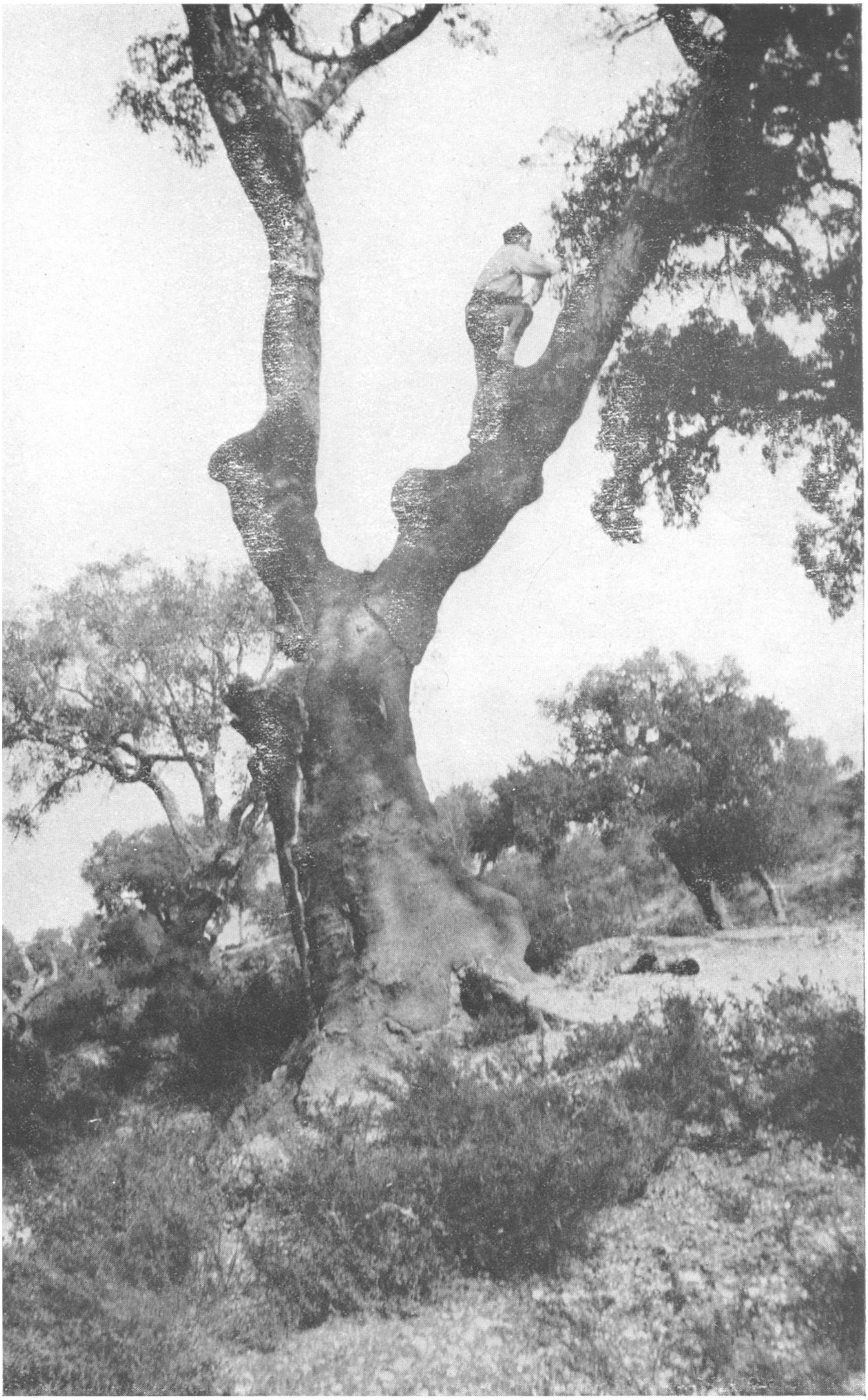

FIG. 1—Cork bark stripper at work. The unstripped portions of the bark may be seen on both branches above the level of the man's head.

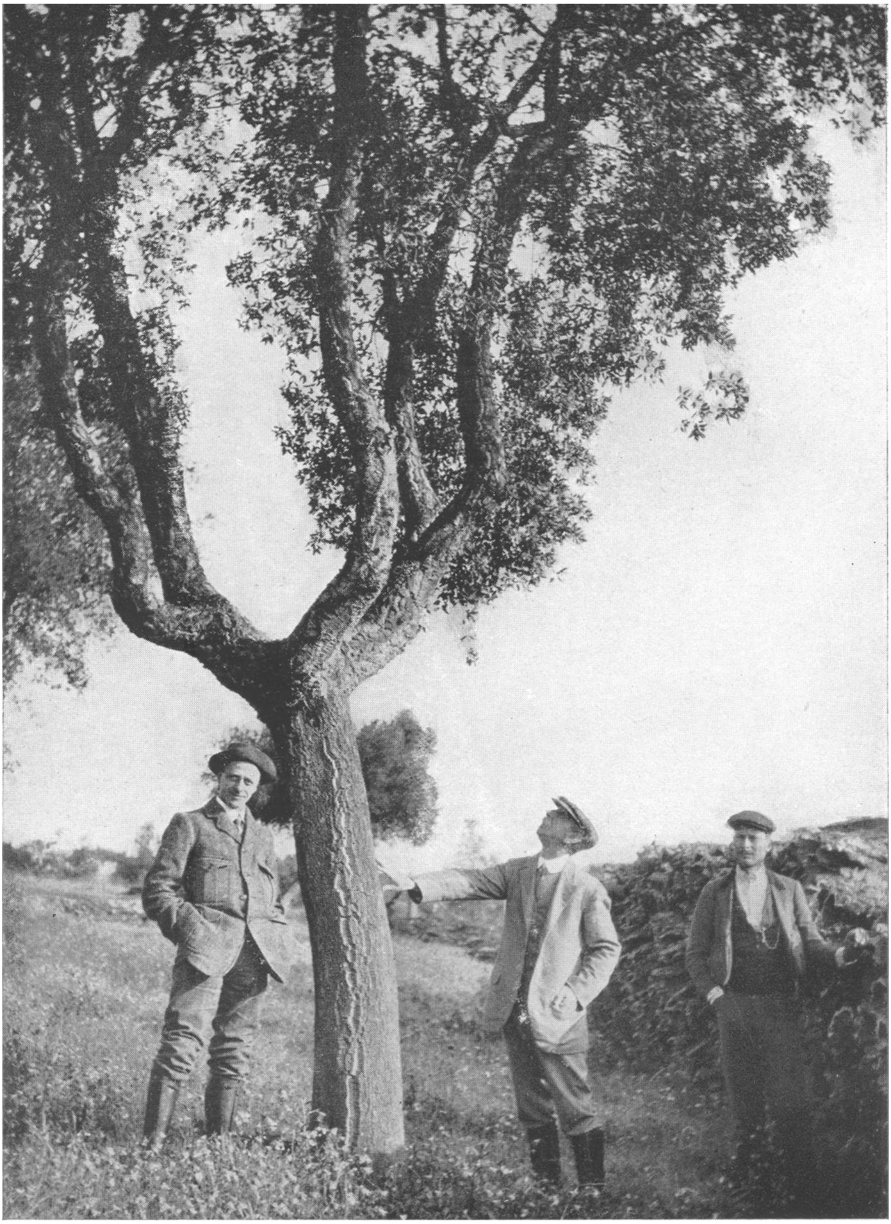

FIG. 2—Young cork-oak tree raising a second layer of cork. Branching limbs of the desired shape. The four limbs will produce more cork than the one trunk.

the would-be conservators have not had enough faith in this process of negation to mention it in connection with the greatest and most menacing of all resource wastes—soil erosion. This is the irreparable destruction, man's greatest crime against his environment. Most of the minerals can be substituted, and, as long as soil remains, the forests and fields can be restored, but where soil erosion does its deadly work, the possibility of forest production, and yet worse, the possibility of food production, is reduced or destroyed for an indefinite and often very long period—a geologic epoch, perhaps. Without a food supply an environment ceases to support man, despite the most wholesome and invigorating climate. The climate is then wasted. It is a fact rarely appreciated that some of tho worst soil destruction now going on in the world is taking place in climates of high excellence right here in the United States. It is also probably true that this soil destruction is going on faster and also over larger areas than ever before in the world's history.[1]

As a means of getting more food and useful commodities out of the earth, with greater ease and with conservation of the soil, I here call attention to the idea of a new agriculture, a tree-crop agriculture, which seems to hold the promise of easily doubling our productive area and making revolutions in man's relation to his environment second only, perhaps, to the influence of steam. These new utilities arise from discoveries in economic botany which are hinted in the four words, *variation, heredity, propagation, culture.* If fruit and nut trees not yet recognized as crops in the United States equaled cement in the amount of study, exploration, and experiment bestowed upon them, tens of thousands of people would recognize at once that we have at our disposal a new means of utilizing the environment which would conserve it and at the same time double its capacity for supporting man, perhaps even with a diminution of effort.

In attempting to present the possibilities of such a new agriculture, such a new connection with the environment, I submit some data concerning the oak tree as a producer of crops other than wood.

I choose the oak deliberately because it seems to most people a peculiarly hopeless basis for an agricultural crop. We think of it as symbolizing strength, sturdiness, and the impossibly slow beginnings from that little acorn. This I believe is largely due to a concept that the poets have wrought into us. The oak trees should sue the poets for damages to a reputation that should otherwise be good.

The oak tree, without sacrificing a pound of wood, gives rise to one of the chief exports and two of the important industries of Portugal. If I wanted to be comfortably and permanently rich, I could ask for few more secure bases for it in the line of agricultural lands than the undisturbed possession of a few hundred acres of Portuguese land with a good stand of cork-oak trees (*Quercus suber*) and evergreen-oak trees (*Quercus ilex*). If the stand of trees was good, it would make little difference if the land happened to be rough, untillable hillsides. It would still yield its crops of cork and pork—the pork made of acorns. The virtues of the Portuguese cork forests are quadruple, and they are almost perpetual.

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[1] J. Russell Smith: Soil Erosion and Its Remedy by Terracing and Tree Planting, *Science*, Vol. 39, 1914, June 12, pp. 858-862.

With reasonable care, which consists of occasional cuttings-out of an undergrowth of bushes inedible to the goat, and occasional thinnings, the forest will live for centuries and yield four kinds of income. The trees yield best of both cork and acorns when the stand is not thick enough for the trees to crowd each other. This permits some growth of forage for sheep and goats. It is the common expectation that the income from this source in a proper oak forest will pay for the labor of grubbing bushes, which, aside from fire protection, is the only maintenance charge. That leaves the other three sources of income, wood, cork, and pork, to offset interest and taxes and make profit. The landlord's task is easy, as the pasture is rented by the tract, the cork is sold to contractors by the ton, the wood by the cubic meter, and the hog pasture on some lump arrangement.

Every nine or ten years the cork bark is stripped. An acre with a full stand of young trees will have seventy trees yielding fifteen kilograms per tree, or 2,300 pounds per acre. As the trees get older and are thinned out to prevent crowding, the increased yield per tree keeps the cork output up to the average which, with care, can be maintained at over a ton per acre indefinitely. Cork is now worth about seventy-five dollars per ton. When the trees come down, they make the precious charcoal by which the Portuguese nation shivers in winter while it cooks its simple meals. In the properly cared-for forest every old cork tree has beneath its branches several half-starved understudies leading a submerged life until it comes their turn to have space in which to spread. I have seen a large cork tree, fifteen feet in girth and with a reach of fifty-six feet, that had yielded 1,980 pounds of weighed cork at a stripping.[2] An acre will easily hold eleven such trees, and I am told by competent authority that there are many such acres in Portugal. It is an interesting and peculiar fact that the poorer the land the better the cork. This results from a finer texture due to slower growth and causes some fine cork forests to be on sandy or stony land, which in any other country would be called "barrens" and would find its highest productivity by growing a pine forest. In some districts the trees are made the sole basis of estimating the value of the land on which they stand. Near Evora, in south-central Portugal, the method of calculating the value of a cork forest is as follows. The twenty-year yield of cork (two strippings) is taken as the basis. The buyer pays 600 to 650 reis (1,000 reis=$1.08) per *arroba* (33 pounds) of cork capacity. Thus a good acre of cork trees would bring $125 or more, and the seller throws in the land.

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[2] Figures from a careful English owner with an engineer's training.

In America every teacher of economic geography is hammering into the heads of his students the relationship between the corn belt and meat production. If such a teacher should by any revolution in education get into Portugal, he would be emphasizing the relationship between cork and pork. English owners of cork estates in Portugal estimate that acorns alone produce from half to two-thirds of the total pork crop of that country. The Portuguese hog leads a lean and hungry life for a year and a half or two years, and then comes an orgy during which he eats acorns all day and sleeps on them at night. In three months he doubles or triples his weight and passes on to the ceremonies at the abattoir.

As the acorn crop is not under much control of man and does not come regularly, it is difficult to make an exact approximation of pigs and acorns. This difficulty is met by the organization of fortnightly markets in the villages of the cork regions where pigs in any and all stages of fatness and leanness are bought and sold at any and all times. Two weeks before the pig is completely fatted, he may be sold by the man who has a shortage of acorns to the man who has a surplus. Careful experiment in central Portugal has shown that 5.3 liters of acorns will make one pound of pork. By means of this Rosetta stone we can get some idea of the acorn yield, which in years of full crop is surprisingly heavy. In estimating the number of pigs to buy, the farmer walks through his forest scanning the trees and the acorns on the ground, and every time he sees the fattening for one more pig, he puts an acorn in his pocket. Such a man, a manager of an English-owned estate, has told me that big cork trees will yield 100, 200, 300, and even 400 kilograms of acorns, but not 500 kilograms.

On the unfenced acres of a cork estate two kinds of herders are daily abroad: the swineherd, whose wards eat grass and acorns, and the shepherd, whose sheep and goats browse the bushes and grass and furnish wool and milk, the fifth and sixth products of the cork forest.

As I rode through one of these estates on an April day, I came upon a long lane full of sheep, seven hundred of them, crowded solidly between close fences and two shepherds busy at their regular afternoon job of milking them. They started at one end of the long and motley mass and worked their way through it. One presided over the milk bucket, the other caught the ewes, backed them up to the bucket, and held them for the milker to extract a few spoonfuls of rich milk, after which the poor beasts were pushed aside to join the growing mass of the recently milked. That evening at the house of João Dias, estate foreman, I had for supper rich cheese of sheep's milk, but my appetite for it was not increased by the memory of the first process of its making.

The evergreen-oak (*Quercus ilex*) has bark of no value, but is a greater yielder of acorns than is the cork-oak, so that no Portuguese will cut down the one tree for the other, so absolutely are they valued alike. Often the two species are mixed indiscriminately in the same tract, but in some

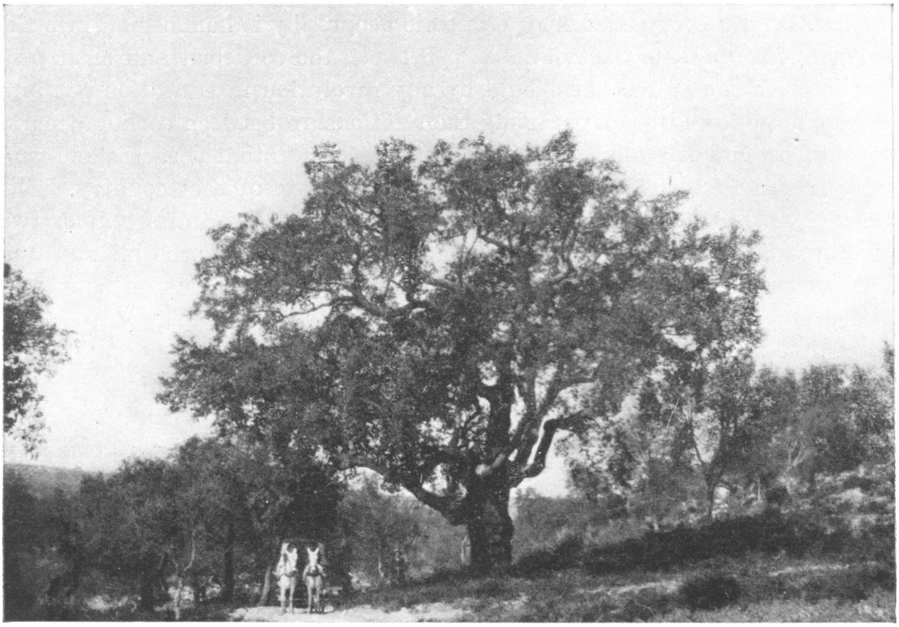

FIG. 3.

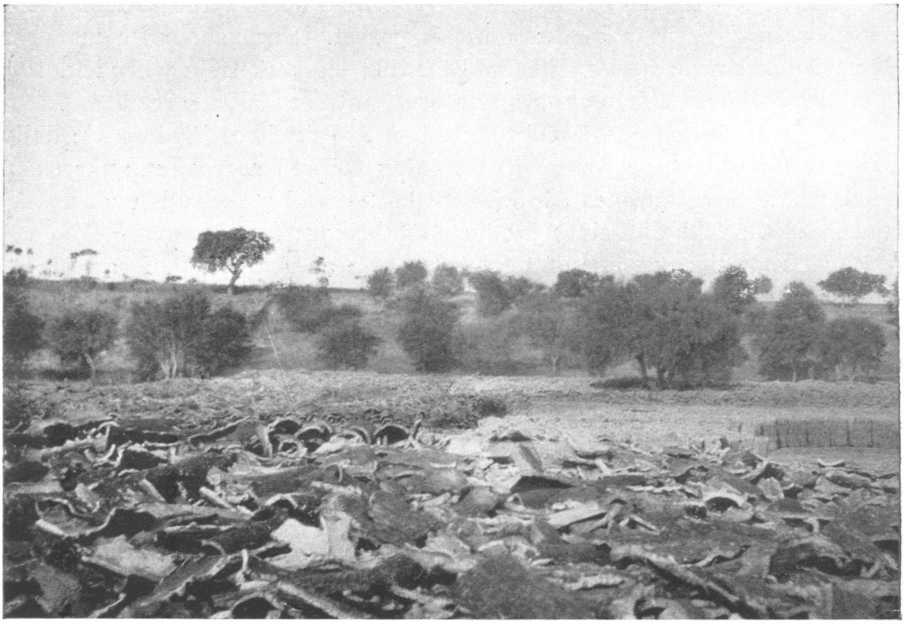

FIG. 4.

FIG. 3—Cork tree with a weight record of 1,980 pounds of cork at one stripping.

FIG. 4—Piles of crude cork awaiting shipment at railroad station, central Portugal. Cork trees in the background.

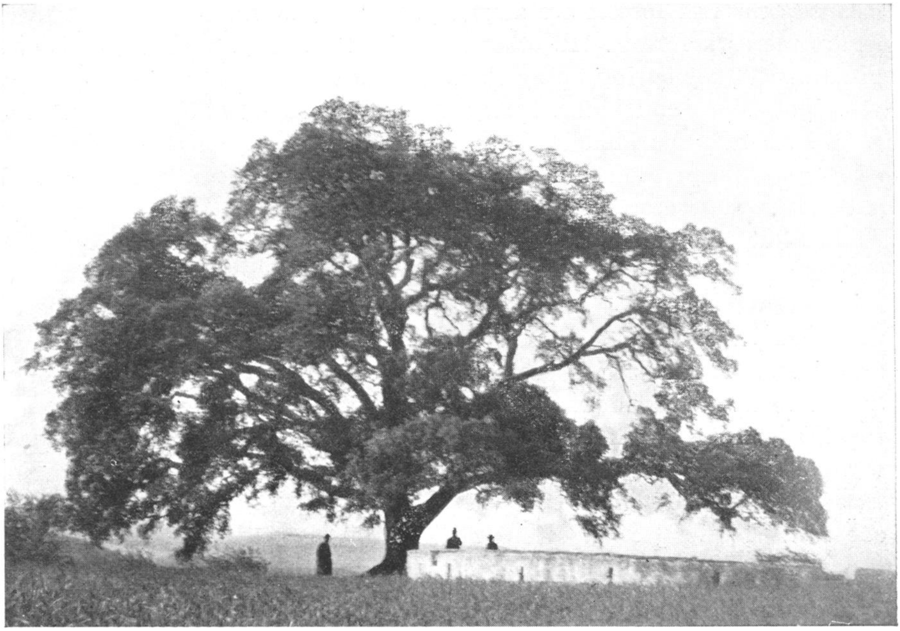

FIG. 5.

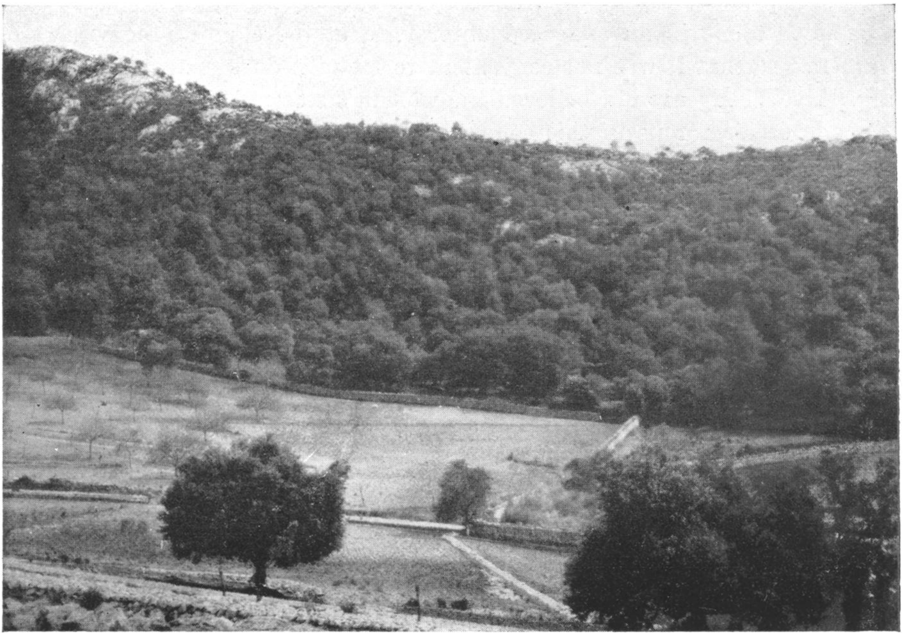

FIG 6.

FIG. 5—Large ilex tree in southern Portugal with an average acorn yield of 720 liters and a maximum of 1,200 liters.

FIG. 6—A Majorca farm. Cultivated fields in the valleys; ilex forest on the limestone hill beyond, highly valued as a hog-fattening range. Note the rounded heads of the trees, showing that they have been thinned out to permit full individual development.

localities the ilex forests are almost pure stand and are cared for exactly as are the cork forests. In other localities the young trees are allowed to grow where they spring up by chance in the fields, and the ordinary cultivation of wheat and beans, barley and hay, goes on just the same. This gives a beautiful parklike landscape; the cultivation helps the oaks to make acorns; and after the grain crops are harvested, the hogs are turned in to gather the mast crop.

Reliable records of measured yield of anything are hard to secure in such a land of hit-or-miss as Portugal, where the average farmer does not know even the size of his farm. He often buys it or rents it by the unmeasured piece, as we do horses. The difficulty of getting records of yields of oak trees is further increased by the practice of letting the animals do the harvesting. But down in Algarve, the southernmost province of Portugal, I heard of an ilex that bore 1,200 liters of acorns. The definiteness was pleasing to the ear of one in search of facts, and the size of the yield was surprising. I went to see the tree, which had a reach of only fifty-one feet. By long and devious methods I cross-questioned the owner, a widow of sixty, more or less, but she always struck to it that the tree bore 1,200 liters on full years and 240 liters in the alternate years, and that the average was 720 liters per year. She said she knew, because she picked them up and sold them in the village. Selling acorns is a common but not extensive practice in many parts of Spain and Portugal, and this woman's tree stood alone in an unfenced outer yard at the edge of the village of St. Bras, so that it was not convenient to let pigs do the work of harvesting. Everybody around believed the woman's statements, a process which is made easier for us in this country by the statement in the September, 1915, number of the *Journal of Heredity* that a certain valley oak tree in California bears a ton of acorns as a full crop. (The average yield of corn per acre in the United States is about 1,400 pounds, or 800 quarts.)

On the slopes of the Sierra Nevada in Spain, a few miles south of Granada, I saw the ilex rendering its supreme service—holding the earth for man and at the same time giving him a living. In this locality the formation was unconsolidated clay and gravels of such depth that no bed rock was anywhere in sight. The slopes and height were such that the name mountain would be applied perhaps even by the Swiss. On one of these slopes I examined an ilex orchard that was giving a fair return as part of a farm. A part of this orchard was so steep as to be very difficult of ascent. When the tenant told me he let his hogs run there, I asked him how he kept them from falling out into the stream below. "Oh," he said, "I don't let the big fat ones come here. I'm afraid they would fall. I only bring the little ones into this part." A mile away, on a less steep part of the same slope, men for centuries had been supporting themselves by the agriculture of the plow, and nature had shown her resentment of this act of violence. In some places from half to three-fourths of the original land surface was gone, through the work of gullies that were from fifty to two hundred feet deep. "After man the desert" was here literally being put into effect. The ilex slope was much the more productive of the two, and it had been saved by being so steep that it could tempt no plowman.

In Corsica, where a very systematic and effective tree-crop agriculture has been worked out with the productive grafted chestnut tree as the main dependence, the ilex is a secondary crop of no mean importance, although, for some unaccountable reason, the people have not improved it by grafting as they have done in the case of the chestnut. This oak will grow at greater altitudes than the chestnut, and it spreads out in a far-reaching zone on the higher slopes above the chestnut forests. Here, as in Iberia, acorns are used for fattening swine and goats.

It is in the Balearic isle of Majorca that we see indications of the highest possibility of the acorn, namely, its service as food for civilized man. The acorn analyzes well, being nearly as nutritious as maize, except for a part of the protein content. This highly starchy nut—for it is a nut—is mostly too bitter to be relished as human food, because there is a certain amount of tannin present, but, owing to the ever-present variations of individual trees, there are some ilexes that bear acorns as much prized for human food as are chestnuts. Twigs from some of these choice trees have, for a century or two, been grafted upon the common kinds in a few localities of Majorca and the Spanish mainland, and the fruit is sold in competition with and at the same price as the chestnut. Why has this not become an extensive industry? That question can only be answered by asking others. Why have not the people of the United States copied the Corsicans, French, and Italians in developing orchards of improved chestnuts on our own steep and rocky slopes where the wild chestnut tree has been ready for grafting ever since the first settlers landed?

The acorn, despite its bitter flavor, has served and yet serves as an important food supply for many isolated primitive peoples, especially in years of poor harvest of their tilled crops. Examples of this are found among the Berbers of the Atlas and the Indians of Nevada and California. Ethnologists could doubtless multiply examples by the score, and it has almost certainly been one of the important foods of primitive and prehistoric man in the oak-growing regions which nearly encircle the earth in the north temperate zone. The low protein content of the acorn makes it an admirable food to balance the meaty ration of a hunting tribe. Mr. George B. Sudworth, dendrologist of the U. S. Forest Service, reports that an Indian tribe in Nevada makes an annual autumn excursion over the Sierra into California. There they busy themselves in the national forests gathering acorns and carrying them out to the trails in sacks. Thence they are packed or hauled over the mountains to the tribal home, and the bread supply for a year is secure. It is a part of the squaws' regular

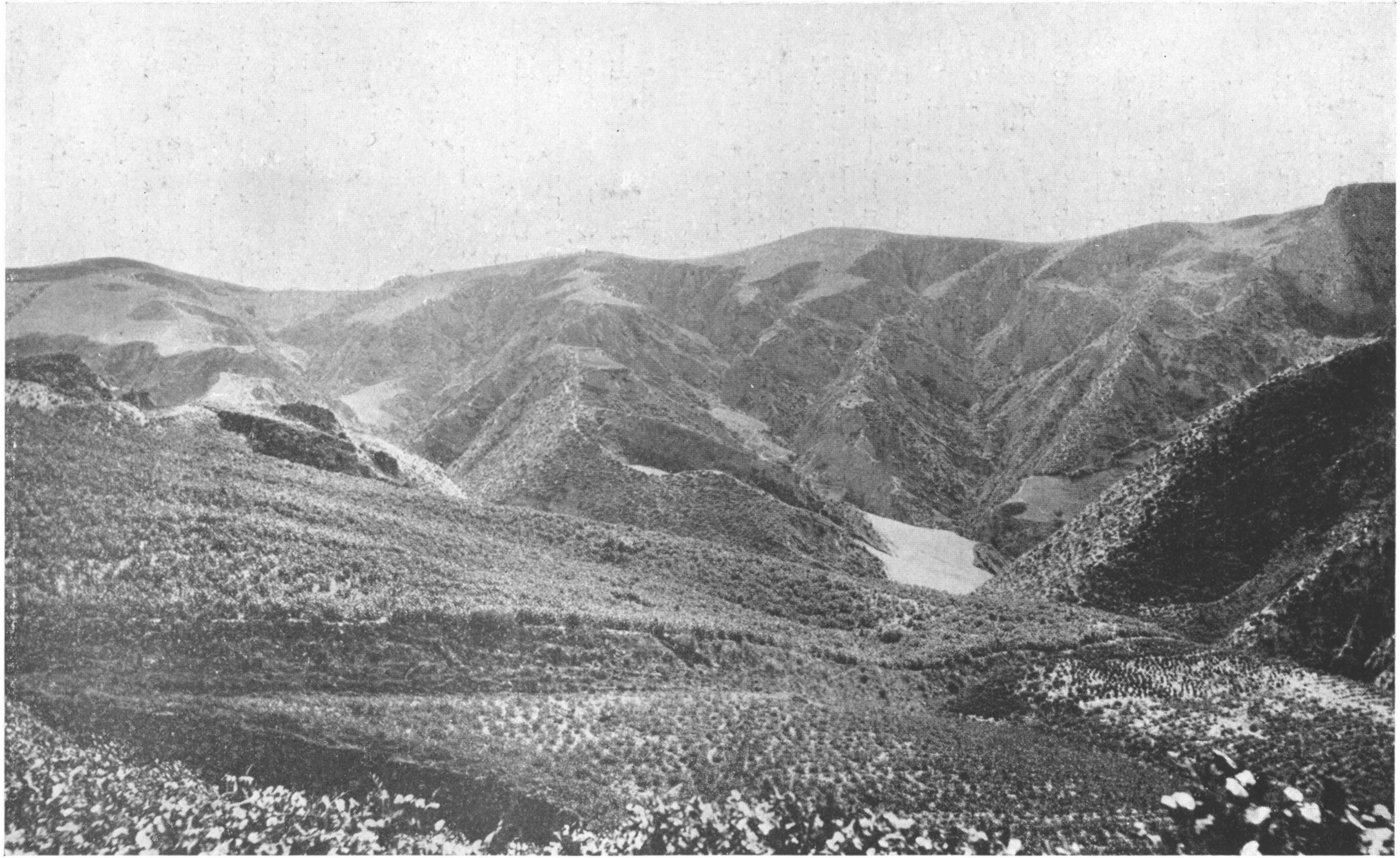

FIG. 7—Effect of soil erosion in the border region of the Sierra Nevada near Granada, Spain. The ridge in the background has been ruined by erosion, which has cut gullies 200 feet deep: the smooth level tops are all that remain of what was originally an agricultural surface. The slopes in the middle ground and foreground, being too steep for the plow, were saved from a similar fate. Planted with ilex trees, whose acorns form the chief fodder for swine, they are much the more productive of the two areas.

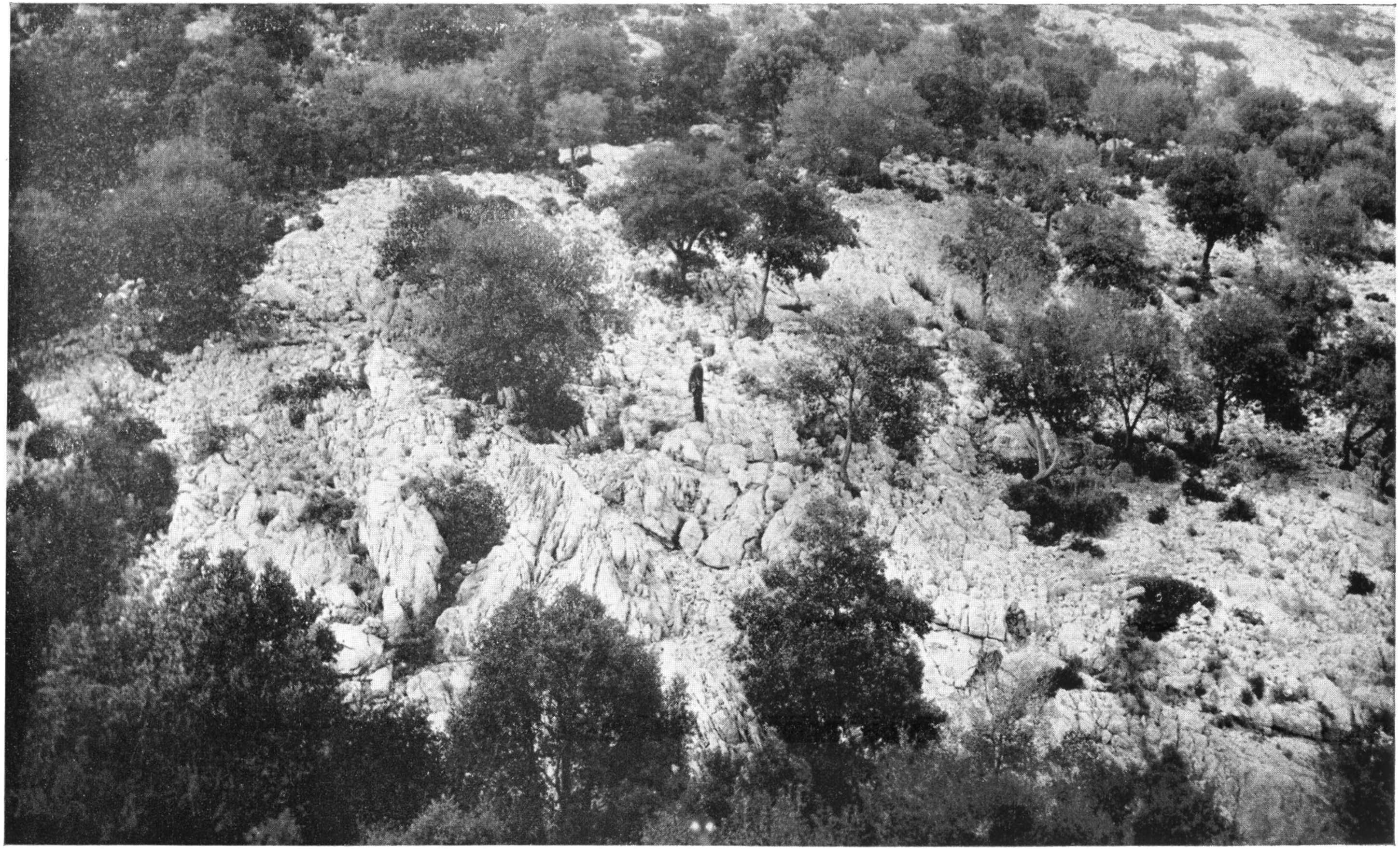

Fig. 8—Hillside of limestone in Majorca. Ilex trees wedging themselves into the crevices of the rock and yielding a crop.

routine daily to pound up a portion of acorn meat and soak it in water that the tannin may be dissolved and the bitter meal made sweet. The coarse, wet farinaceous mass that remains is the oatmeal, shredded wheat biscuit, corn meal mush, pone, or wheat flour for the tribe. I should be much interested to know what a good industrial chemist could do with that liquor containing the tannin extract, for tannin is scarce. And I have great faith that in this day of blended foods the Bureau of Chemistry at Washington might, with some mixture of grains, sugars, and starches, produce an excellent food like shredded wheat or crackers which could have acorns as its base, be made in a factory, and keep for weeks or months.

In speaking of the possibility of the acorn as human food, I wish to emphasize the fact that I am pointing out possibilities only. Man likes to eat what he likes, and he is very conservative about making changes. Serious consideration of the acorn as an American crop should be along the lines of its real importance in Europe—forage. Our rising price of meat indicates a shortage of forage, a shortage which promises to grow keener as population increases faster than fields. It is rarely appreciated that something like nine-tenths of the produce of American agriculture goes to feed our animals. There is the constant menace of over-production in many of the crops that man himself eats directly, but for forage, for animal food, which may give us cheaper meat, more leather and wool, there is almost indefinite room for expansion.

Even America is not without suggestive beginnings in the use of the oak tree. The U. S. Forest Service annually admits two hundred thousand or more swine to the national forests for a consideration. The acorn is one of the chief reasons why the owners of these animals pay for their admission to the forests. This practice is almost the exact duplicate of the way it is done in Spain and Portugal. I have found a farmer in the coastal plain of Georgia who thinks that his plantings of the water-oak are making more hog food with its acorns than corn would yield on the same poor sandy soil. I have found another experimenter on the clay hills of the Georgia highlands who thinks the chestnut-oak one of the most promising forage plants for large areas of Appalachia. At Hubert, Minnesota, Colonel Freeman Thorpe, a private investigator with faith in trees, has become convinced by his experiments that the Minnesota black-oak can be made to yield a hundred bushels of acorns per year on soil that will not make one-third that much corn.

This accumulation of experience of the Old World and the New World seems to show beyond peradventure that the oak genus with its many fruitful species is worthy of careful investigation by agricultural science. The case seems almost analogous to the first discovery of reinforcing in concrete and its relation to engineering science.

What is agricultural science to do with the oak tree? Four things may

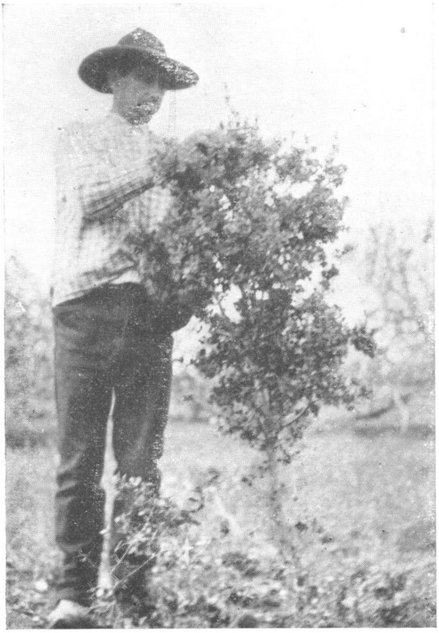

FIG. 9.

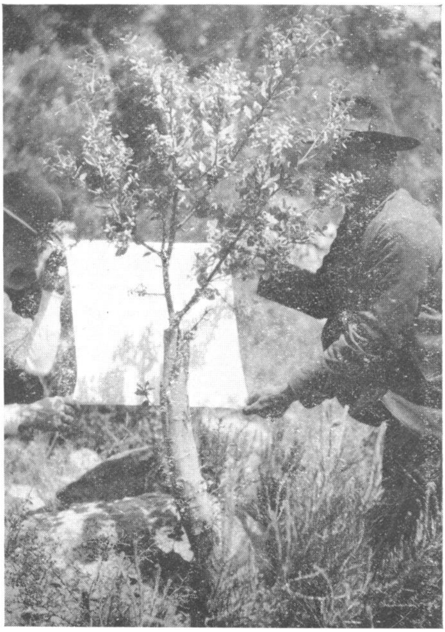

FIG. 10.

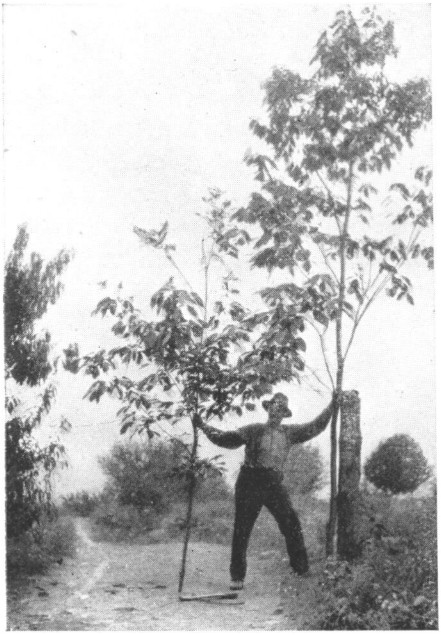

FIG. 11.

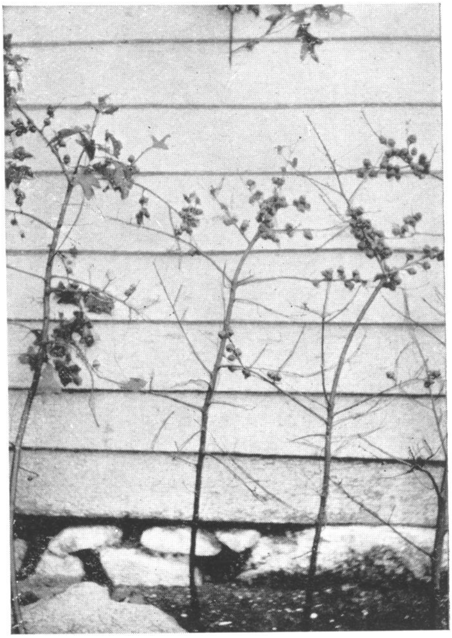

FIG. 12.

FIG. 9—Young ilex tree, central Portugal, in full bloom. Peasant by it declared it bore "about two hundred acorns the preceding season."

FIG. 10—Young grafted ilex tree in Majorca, Balearic Islands.

FIG. 11—Chestnut-oak trees grown from shoots around stump of trees that had been cut seven years previously on the Blue Ridge in northern Virginia. Both trees are bearing acorns.

FIG. 12.—Turkey-oak photographed thirty months after desolation by forest fire on the quartz sandstone soil on top of the Blue Ridge in northern Virginia. The boards in the background are five inches wide.

be done: (1) find the best wild parent trees; (2) propagate them; (3) breed better types; (4) propagate these better types.

The fact of individual variation of specimens has given us the Baldwin apple and the sour roadside crab, both of which are of the same species as recognized by botanists. The first Baldwin apple-tree was a Napoleon among trees which happened to be caught and propagated by the million.

This variation of individuals extends also to the question of precocity, a respect in which the oak trees as a class suffer unjustly in men's minds, as was mentioned above. In Portugal, Spain, Algeria, and Tunis, I have seen hundreds of ilexes not as high as my head, in full bloom. I have been repeatedly assured that they bear profusely at such small sizes and at an age not exceeding that at which the apple commonly begins to bear. But we have more remarkable oak trees in the United States. The crests of many Appalachian ridges are made by a stratum of Cambrian sandstone or quartzite in which grains of sand, held together by a silicious binder, break up slowly into a sandy soil of most pronounced sterility. Where its physical conditions would permit agriculture man shuns this soil as he would the Sahara. Yet several species of dwarf oaks grow in this forbidding ground. One of them is reported by Dr. Charles S. Sargent to lie over on the ground, so great is the burden of its acorn crop. In the Maryland, Virginia, and West Virginia section there is a low-growing species, having fruit within two feet of the ground, called the turkey-oak for obvious reasons. On one particular stretch of the above-described quartzite soil that has come under my observation, there has been a forest fire every two or three years for the last forty years at least. In April, 1910, I saw one of these fires, which burned everything to the ground. Thirty months later the turkey oaks were thirty inches high and full of fruit. Such quick and continued fruitfulness from such sterility seems little short of miraculous and certainly shows a combination of qualities that man should make efforts to put to economic use. Chestnut-oaks growing on another soil type a half mile distant from the above-mentioned turkey-oaks have produced seed the seventh summer after the shoots sprang up from stumps left by the lumbermen. In the case of these chestnut- and turkey-oaks there was no especial search made for extra specimens. They merely grew by the roadside along which I had to pass. Hybridizing of these species to get the best blend or mixture of their qualities offers an enticing field to the experimenter.

The breeding of plants for definite ends has just begun. It offers great and as yet little-appreciated possibilities. There is small reason to doubt that breeding experiments in the oak genus will permit the essential duplication of the results obtained by Dr. Walter Van Fleet of the U. S. Department of Agriculture with the chestnut. This tree often bears only at an advanced age, but by taking advantage of the precocity of rare individuals

Dr. Van Fleet was able to produce specimens so precocious that they bore eighteen months after the seed was planted.

The producing of better strains by crossing and hybridizing is usually a slow and somewhat difficult scientific process. In any case it should follow a careful search of existing trees so that it may start with the best raw materials. In the meantime many of these naturally produced trees are well worth propagation if they can just be sought out. Let us hope that the economic botanists and the agricultural scientists will soon be able to address themselves to this task.

The oak with its many species, one or more of which cover nearly all sections of the United States, is merely a type. In some sections there are several trees which may by selection, propagation, and hybridization become the vehicles of crops, the basis of a new agriculture.

In the past, agriculture has depended on the plow. If land was not arable, it was not fit for agriculture. The experience of many Mediterranean localities and the evident possibilities of tree crops show that we have at hand the materials for a new tree-crop agriculture that may more than double the productive area of many hilly, stony, and mountainous districts. Such a development promises to bring new and interesting influences to bear upon the wood supply, soil erosion, stream control, and the water supply, all of which are major problems in man's utilization of the environment.